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A FIFTEEN YEAR TIME SERIES OF LONGWAVE AND SHORTWAVE RADIATION MEASUREMENTS FOR ENVIRONMENTAL AND CLIMATE CHANGE STUDIES

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ABSTRACT

Fifteen years of monthly averaged wide field-of-view (WFOV) outgoing longwave radiation (OLR) and reflected shortwave radiation (RSW) numerical filter, 5 degree regional measurements from the Earth Radiation Budget Experiment (ERBE) are made available on the Internet/Web for use by the scientific community. This 15-year data set is from WFOV measurements taken by the dedicated Earth Radiation Budget Satellite (ERBS) which is in an orbit of 57 degree inclination and precesses through all local times in 72 days. The data set has been reprocessed to remove measurements in regions with poor temporal sampling. The data set spans the period from November 1984 through September 1999 and can be viewed and accessed using a web browser located on a server at NASA, Langley Research Center. The browser uses a live access server (LAS) developed by the Thermal Modeling and Analysis Project at NOAA’s Pacific Marine Environmental Laboratory. LAS allows scientists to interact directly with the data to view, select, and subset the data in terms of month, year, latitude, and longitude. In addition to OLR and RSW measurements, statistics that result from calculating regional averages will be discussed. These statistics include shortwave and longwave standard deviation, and the number of measurements that go into each average. The problem of regions with no data will also be discussed.

1. INTRODUCTION

For many years there has been considerable interest in the earth's radiation budget (ERB) or energy balance, which include measurements of absorbed solar radiation, reflected shortwave radiation (RSW), thermal outgoing longwave radiation (OLR), and net radiation. ERB data are fundamental to the development of realistic climate models and for studying natural and anthropogenic perturbations of the climate. Beginning in the mid 1960's earth-orbiting satellites began to play an important role in making measurements of the earth's radiation flux although much effort had gone into measuring ERB parameters prior to 1960 (House *et al*., 1986).

Beginning in 1974 and extending until the present time, satellite experiments have been making radiation budget measurements almost continually in time (Smith *et al*., 1977; Jacobowitz *et al*., 1984; Barkstrom, 1984; Barkstrom and Smith, 1986).

In 1984 major advances were made with the Earth Radiation Budget Experiment (ERBE) (Barkstrom, 1984; Barkstrom and Smith, 1986). This experiment consists of three satellites, two sun-synchronous National Oceanic and Atmospheric Administration (NOAA) polar orbiters, and one precessing orbiter, the earth radiation budget satellite (ERBS), that observes at varying local times. Measurements from these three satellites, independently and combined, provide accurate and well calibrated results for observing the radiation budget of the earth. The ERBE instrument package on the satellites included earth-viewing narrow-field-of-view (NFOV) scanners as well as non-scanner WFOV active-cavity radiometers with different detectors and filters. The scanner instrument package contained three detectors to measure SW (0.2 - 5 µm), longwave (5 - 200 µm), and total waveband radiation (0.2 - 200 µm) (Kopia, 1986). Each detector scans the earth perpendicular to the satellite ground track from horizon-to-horizon. The nonscanner instrument package contained four earth-

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viewing channels and a solar channel (Luther, *et al*., 1986). For each channel there is a total spectral channel which is sensitive to all wavelengths and a shortwave channel which transmits only shortwave radiation from 0.2 - 5 mm. The polar orbiters from the ERBE, *NOAA-9* and *NOAA-10* , had equator-crossing times of 0230 and 0730 LST, respectively at an orbit altitude of 872 km and 833 km respectively. ERBS is in 57 degreea precessing orbit at an orbit altitude of 610 km.

The ERBS was launched 5 October 1984, but the first archived data were from November 1984. The coarse spatial resolution WFOV on the ERBS continues to collect data although its high-spatial-resolution scanner failed 28 February 1990, after 64 months of successful operation. The *NOAA-9* satellite was launched 12 December 1984, and the first archived data were for February 1985. The *NOAA-9* scanner failed 20 January 1987, after two years of successful operation. The *NOAA-9* nonscanner failed 7 November 1988. The *NOAA-10* satellite was launched on 17 September 1986, and the first archived data were for November 1986. The *NOAA-10* scanner failed on 22 May 1989 after 31 months of successful operation. The *NOAA-10* nonscanner failed in 1992.

The purpose of this paper is to describe a subset of the ERBE data set which will be made available over a web site located at NASA, Langley Research Center. The data set covers fifteen years of WFOV measurements and is from the dedicated Earth Radiation Budget Satellite referred to as ERBS and should be useful to anyone interested in research in atmospheric sciences, especially climate studies.

2. DATA DESCRIPTION

All data are monthly averaged gridded shortwave fluxes, longwave fluxes, and albedos from November 1984 through September 1999 for the ERBS WFOV instrument. The 15-year data set for ERBS WFOV is taken from the ERBE S-10 product (S-10 Users Guide). The ERBS data set contains the regional time and space averages of radiant exitance at TOA. The ERBS data set on the web site are 5.0° x 5.0° monthly equal-angle regional averages. The first region of the grid encompasses the area from 0° to 5.0° longitude and from 52.5° to 57.5° latitude. The 5.0° regions north and south of the 57 degree limit of ERBS are given fill values.

Thus, the regional data values that go into producing the maps form a 24 by 72 matrix of 5.0° regions. This matrix represents 24 latitude zones, each zone containing 72 regions represented by longitude. Twelve latitude zones have fill values. Six are northern latitude zones and six are southern latitude zones. There are thus 1728 of these 5.0° grids that produce a map. The first grid is centered at 55.0 N, 2.50 longitude. The last grid is centered at 55.0 S, 357.50 longitude.

3. DATA AVAILABILITY

The 15-year ERBS WFOV data set will be available over a world-wide-web browser located at NASA, Langley Research Center, Hampton, VA. The data sets are made available over the browser by using a live access server (LAS) developed by the Thermal Modeling and Analysis Project (TMAP) at NOAA's Pacific Marine Environmental Laboratory (PMEL) (Hankin et al., 1997). The LAS is dynamic in that gridded data variables such as OLR, RSW, albedo and associated images can be viewed in their entirety, or the data files may be regionally subsetted, say as a function of space (latitude, longitude) and time (year, month). The LAS is very versatile in that it can display many variables, and they can be saved as tab or comma delimited or generic ASCII files or as NetCDF files.

4. DISCUSSION OF DATA

From the data base on the server, monthly averaged albedos, RSW, and OLR and their associated maps can be viewed using the live access server, LAS. Standard deviations of RSW and OLR along with the number of measurements that go into calculating monthly averages are also available. If temporal sampling were always adequate, ERBS would mostly have full coverage within the bounds of its orbit inclination, 57° N to 57° S. However, because of its precessing orbit, the ERBS does not provide good coverage of the earth every month at high latitudes. Where sampling is not adequate, modeling is used to help get full coverage. To address the problem of inadequate temporal sampling and modeled results that may not always be good, a stochastic quality assurance algorithm has been developed which in effect does not record OLR and RSW if certain criteria are not met (Smith *et al.*, 2000). For this reason, regions that do not pass the quality assurance test will be assigned fill values and will not be recorded. Incomplete coverage is reflected in the maps as missing grid values. Another point should be noted. If standard deviation shows up as zero in the data it means that data for those regions have been modeled.

To give samples of the 15-year ERBS data set the next four maps are included. The first map in Figure 1 shows OLR for January 1998. The grey scale image (although not as revealing as its color counterpart) shows that OLR patterns are zonal in nature, and mainly influenced by surface temperature, cloud cover, cloud height, temperature lapse rate, and moisture content of the atmosphere. For this particular month poor sampling at the higher latitudes was not a problem for OLR monthly averaged results. This means that all gridded regions passed the quality assurance algorithm test. The standard deviation map for OLR is shown in Figure 2. Most of the land regions are modeled results, thus standard deviation is not defined for these regions. Figure 3 is a map of RSW for January 1998. Note that many gridded regions are missing because these measurements did not pass the quality assurance algorithm test. Regions in equatorial, tropical, subtropical, and mid-latitudes show RSW in a range from 60 - 150 W/M^2 due to cloud cover. Figure 4 is a map showing standard deviation of RSW. Standard deviation is rather high, tending to be high where RSW is high and low where RSW is low.

Figure 1

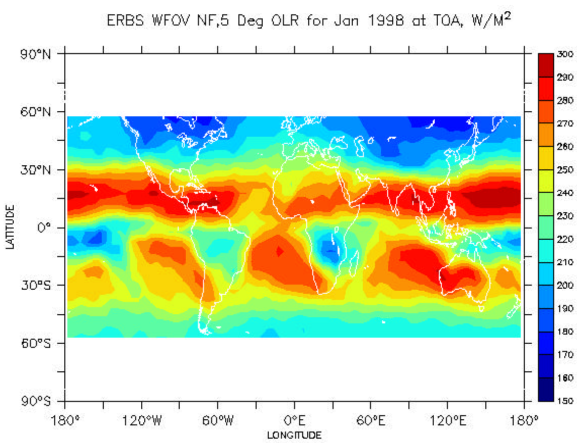
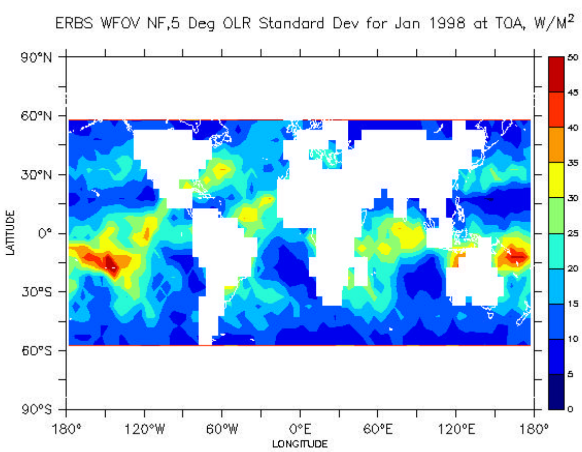


Figure 2



5. SUMMARY

A 15-year data set of satellite radiation measurements from the ERBS WFOV instrument and means of displaying and accessing via the world wide web (WWW) have been described. A live access server (LAS) enables one to interact directly with the data sets to select and subset data sets in terms of space and time. The data sets can be used to study environmental and climate change and time series analysis.

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Figure 3

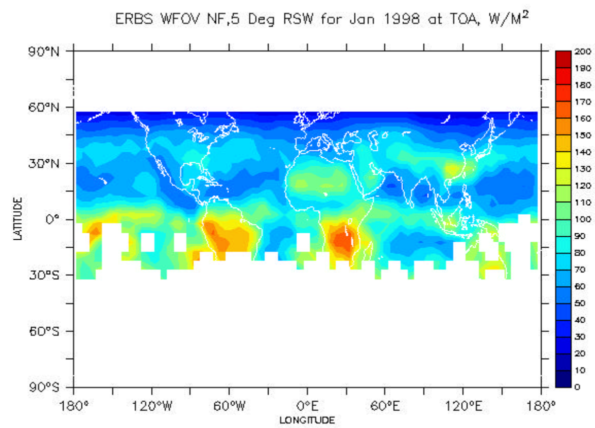
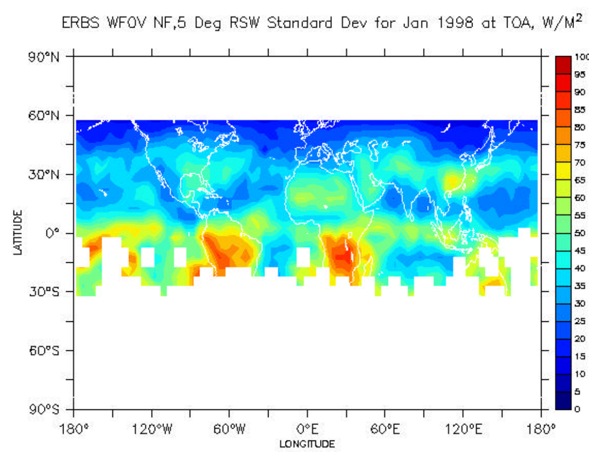


Figure 4



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